METER
ENVIRONMENT

SOIL SENSORS HELP TURF GROWERS FIND WATER/ NUTRIENT BALANCE

Dr. Gaylon S. Campbell

Many athletes don't like artificial turf. They say it's hot, uncomfortable to run on, causes burns when you slide or fall on it, and changes the way a ball moves. Professional women's soccer players even started a lawsuit over FIFA's decision to use artificial turf in the 2015 Women's World Cup.

Some universities—including Brigham Young University—have responded to athlete concerns by using natural turf fields for practice and in their stadiums. But the challenge is to develop plants and management practices for natural turf that help it stand up to frequent use and allow it to perform well even during the difficult fall months. It's a perfect research opportunity.

BYU turf professor, Bryan Hopkins and his colleagues in the Plant and Wildlife Department, have set up a new state-of-the-art facility to study plants and soil in both greenhouse and natural conditions. The facility includes a large section of residential and stadium turfgrass.

BEFORE SOIL SENSORS

Initially, BYU maintained the turf farm grass on a standard, timer-based irrigation control system, but over time they realized that understanding the performance of their turf relative to moisture content and nutrient load is crucial. Last year during Memorial Day weekend their turf farm irrigation system stopped working when no one was around to notice. During those four days temperatures rose to 40 °C (100 °F), and the grass in the field slipped into dormancy due to heat stress. In response, Dr. Hopkins began imagining a system of soil moisture sensors to constantly monitor the performance of the turf grass. He wanted not only to make sure the turf never died but also to really understand the elements of stress so they could do a better job growing healthy turf.

TEROS 12 soil moisture sensor

SENSORS GIVE A CLEAR PICTURE

Soon afterward, a team of scientists, including fellow professor Dr. Neil Hansen, installed METER volumetric water content (VWC) and METER matric potential sensors at two different sites: one in the sports turf and one in a residential turf plot. Each plot had two installations of sensors at 6 cm and 15 cm, along with VWC only at 25 cm, to measure water moving beyond the root zone. Combining these measurements, they could clearly see when the grass was reaching stress conditions and how quickly the turf went from the beginning of stress (in terms of water content and time) to permanent wilting point. In addition, ancillary measurements of temperature and electrical conductivity provide an opportunity for modeling surface and root zone temperature as well as fertilizer concentration dynamics.

ERRORS REVEALED

What the researchers learned was that they were using too much water. Dr. Colin Campbell, a METER research scientist who worked with BYU on sensor installation, comments, “We found in the first year that the plants never got stressed at all. So this year, the researchers allowed the water potential (WP) at 6 cm to drop into the stress range (~ -500 kPa) while observing WP at 15 cm (-50 kPa to -60 kPa). We hope this approach will reduce irrigation inputs while creating some stress in the grass in order to push the roots deeper.”

WHAT'S HAPPENING WITH THE WATER?

In turfgrass, drought stress is not the only problem. Overwatering leads to fungus and removal/flushing of the nutrients, which costs money and time to correct. In this video, Dr. Campbell explains how there is often a fine line between too wet and too dry. Monitoring both water content and water potential keeps turfgrass at optimal moisture levels.

Turfgrass Screencast Video

Dr. Campbell says, "Most people believe that they have an intuitive feel for water availability in soil. If we were only using water content sensors, seeing a typical value of 20% would lead us to believe we were comfortably in the middle of the plant available range (A). But in this study, using our colocated soil water content and soil water potential sensors, the data showed readings over 15% VWC were too wet to affect the WP (B). However, once WP visibly changed, it quickly moved toward critical stress levels (C, -1500 kPa is permanent wilting point); it only took two days for the water potential to change from -8 kPa to -1000 kPa. A subsequent dry period (D) shows similar behavior, but this time the 15 cm WP drops to near -1000 kPa."

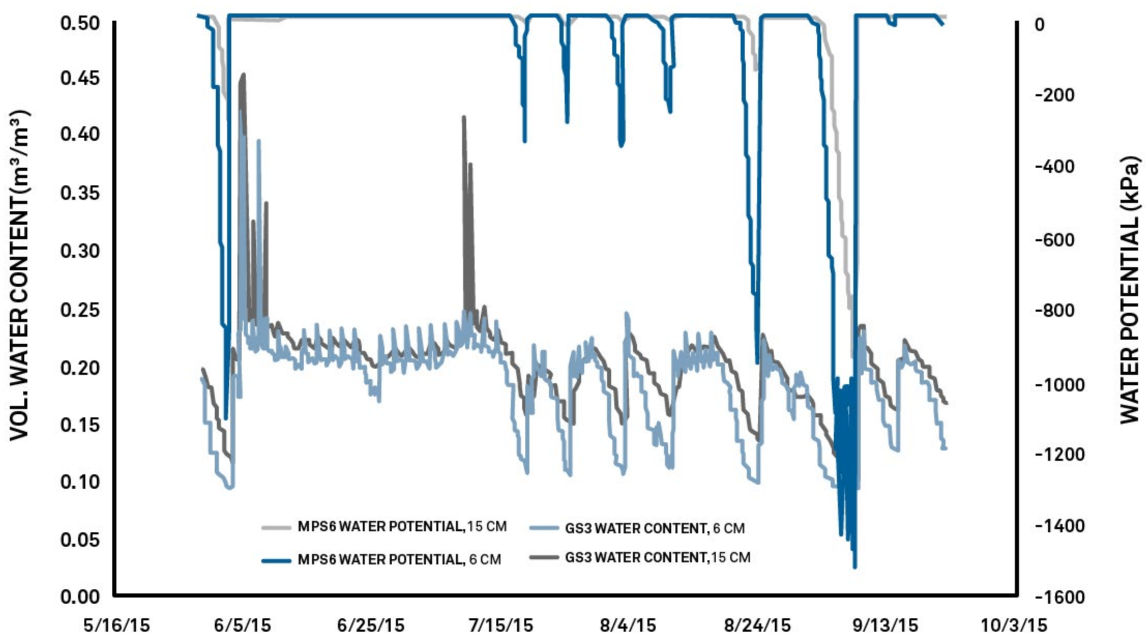

Figure 1. Turfgrass data: both water potential and volumetric water content together

The plant stress levels were reached surprisingly quickly in this soil because its sand composition has a lot of large pores and not very many small ones (Figure 2). Campbell explains, "The large pores store water that is not held tightly due to low surface area, so the water is freely available. But at around 10% VWC all the water from the large pores is used up. As the soil dries beyond that, the water is held tightly in small pores and becomes increasingly unavailable. This is clear in the moisture release curve. We see almost no change in water potential as the soil dried to 16% VWC, but from 10% down to 7%, the water potential reached permanent wilting point, and it happened in just over a day."

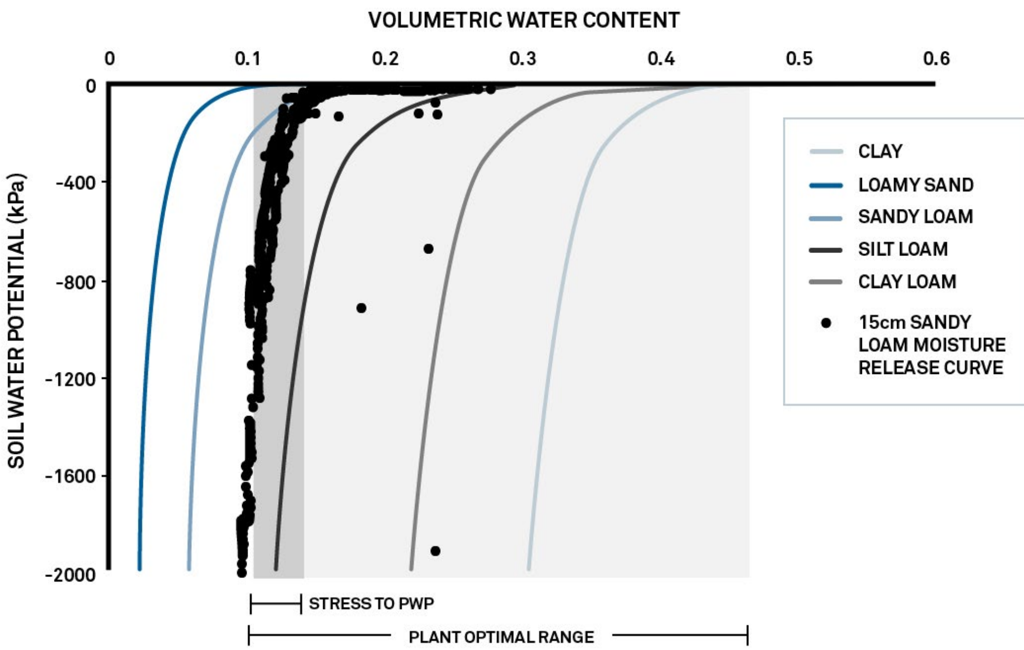

Figure 2. Turfgrass soil moisture release curve (black). Other colors are examples of moisture release curves for different types of soil.

WHAT THE FUTURE HOLDS

The researchers wanted to make sure that if they went down to certain stress levels, they wouldn't cause harm to the plants, so this year, they installed an ATMOS 41 weather station to monitor evapotranspiration and calculate irrigation application rates. They also began measuring spectral reflectance (METER SRS sensor)to monitor changes in leaf area (NDVI) and photosynthesis (PRI). This will enable them to see the impact on the plants as the turf is drying down. "In the future," says Campbell, "we hope that both commercial and residential turf growers will be able to more effectively control their irrigation and nutrients based on what we find in this study."

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